

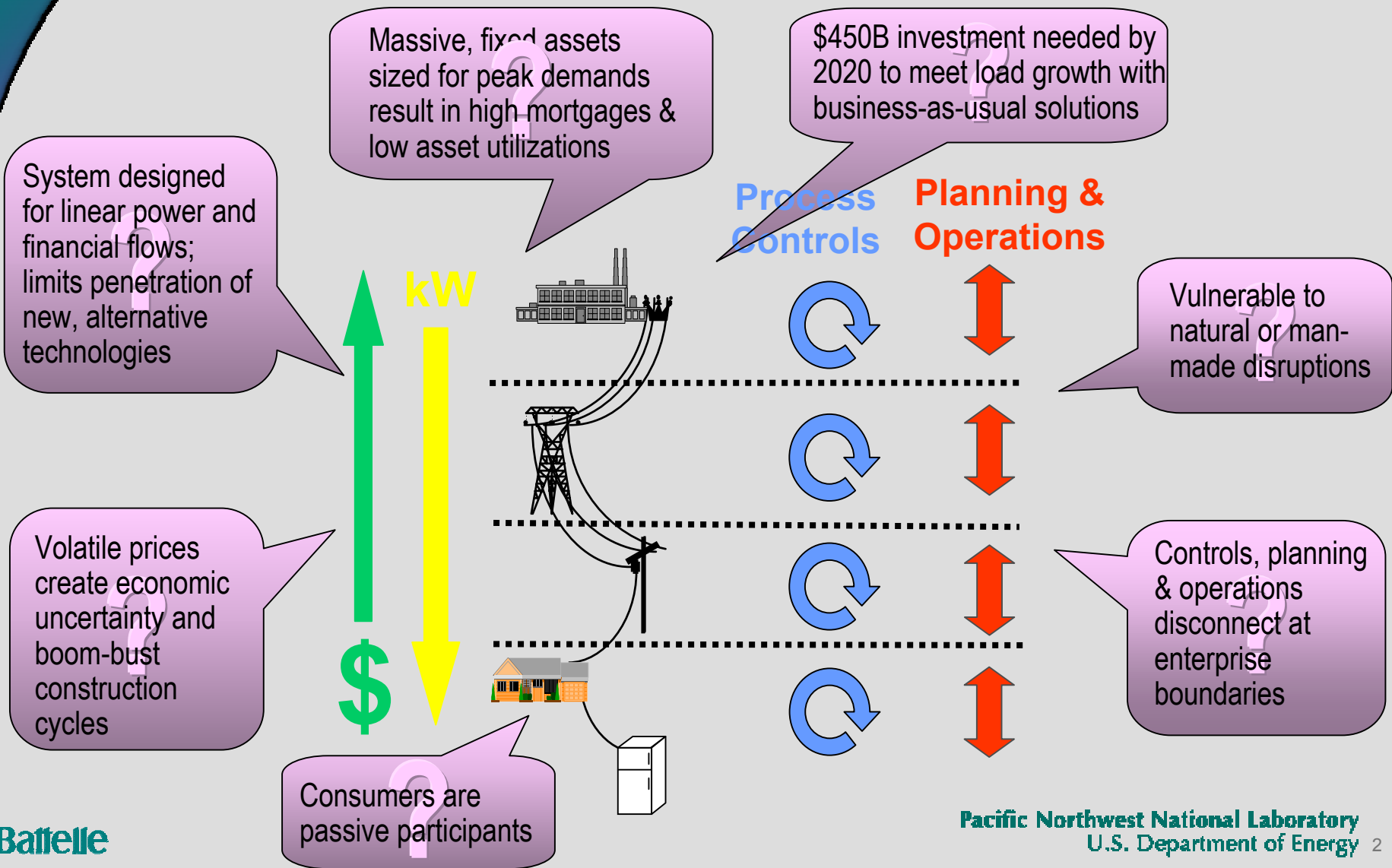
GridWise™:
**A Public/Private Partnership for
Transforming the Energy System**

Bringing Energy into the Information Age

Rob Pratt
Pacific Northwest National Laboratory

June 2003

Issues & Uncertainties Surround Today's Energy Infrastructure



The Transformed Energy Infrastructure

Competitive Distributed Generation

2

disrupts linear power & monetary flow network

opens door for other distributed resources

market operations & monitoring

Advanced Information Technology

4

security and privacy

agent-based controls and operations; diagnostics & prognostics

process planning & operations

markets provide opportunity and incentive for collaboration

Utility Restructuring

1

level markets, short-term, location-dependent value of energy

- Real-time info, e-business, & market efficiencies minimize need for inventory & infrastructure, maximize productivity & asset utilization
- Loads & resources collaborate as a distributed, integrated system with self-organizing & self-optimizing properties of free, fair markets
- Stability, security, crisis management capabilities enhanced
- Rapid, seamless penetration of DG, storage, & load management
- Efficiency & renewables competitive

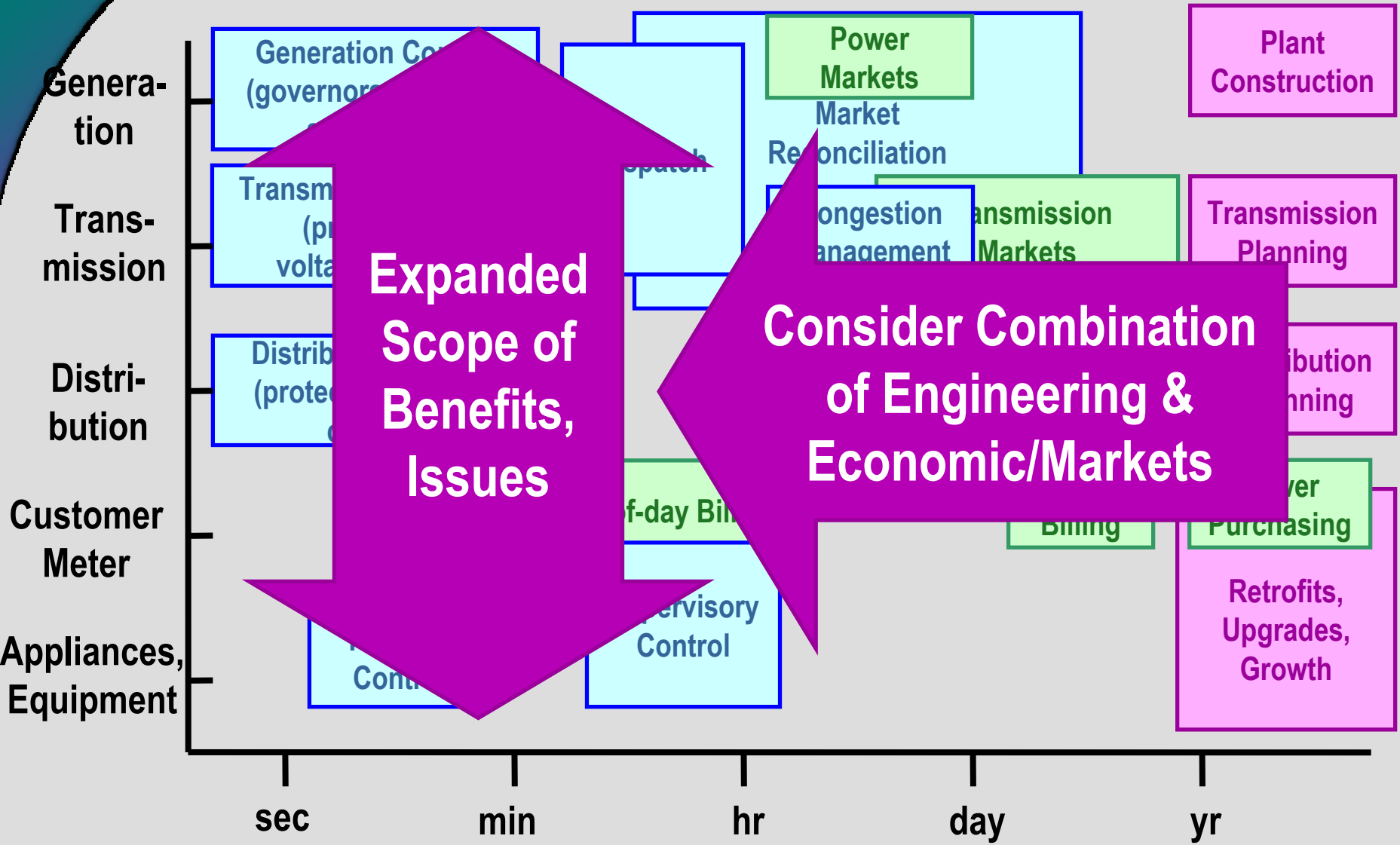
Ubiquitous Communications

3

cross-boundary

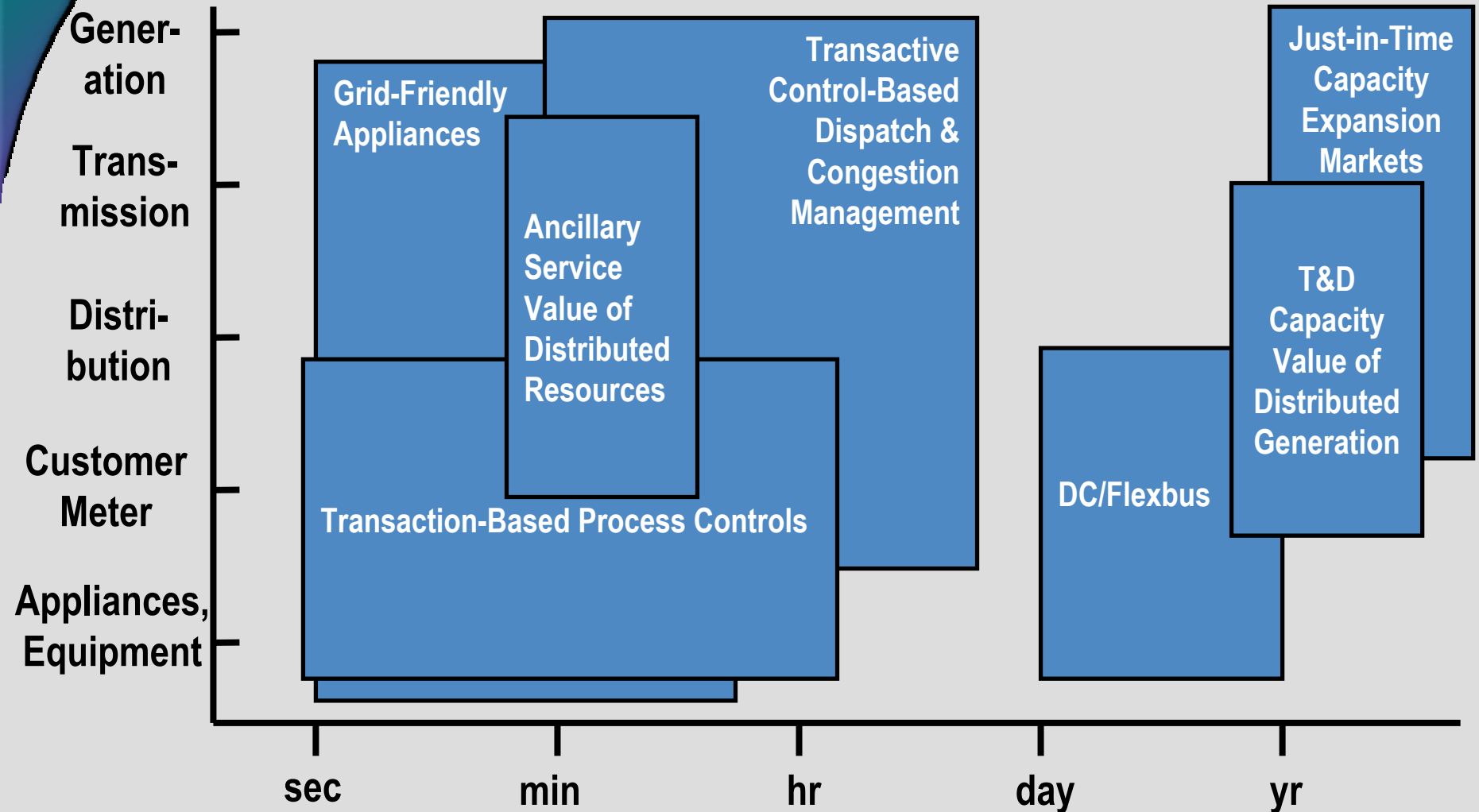
Today's Energy System Operation & Planning Processes

Engineering
Economics
Both



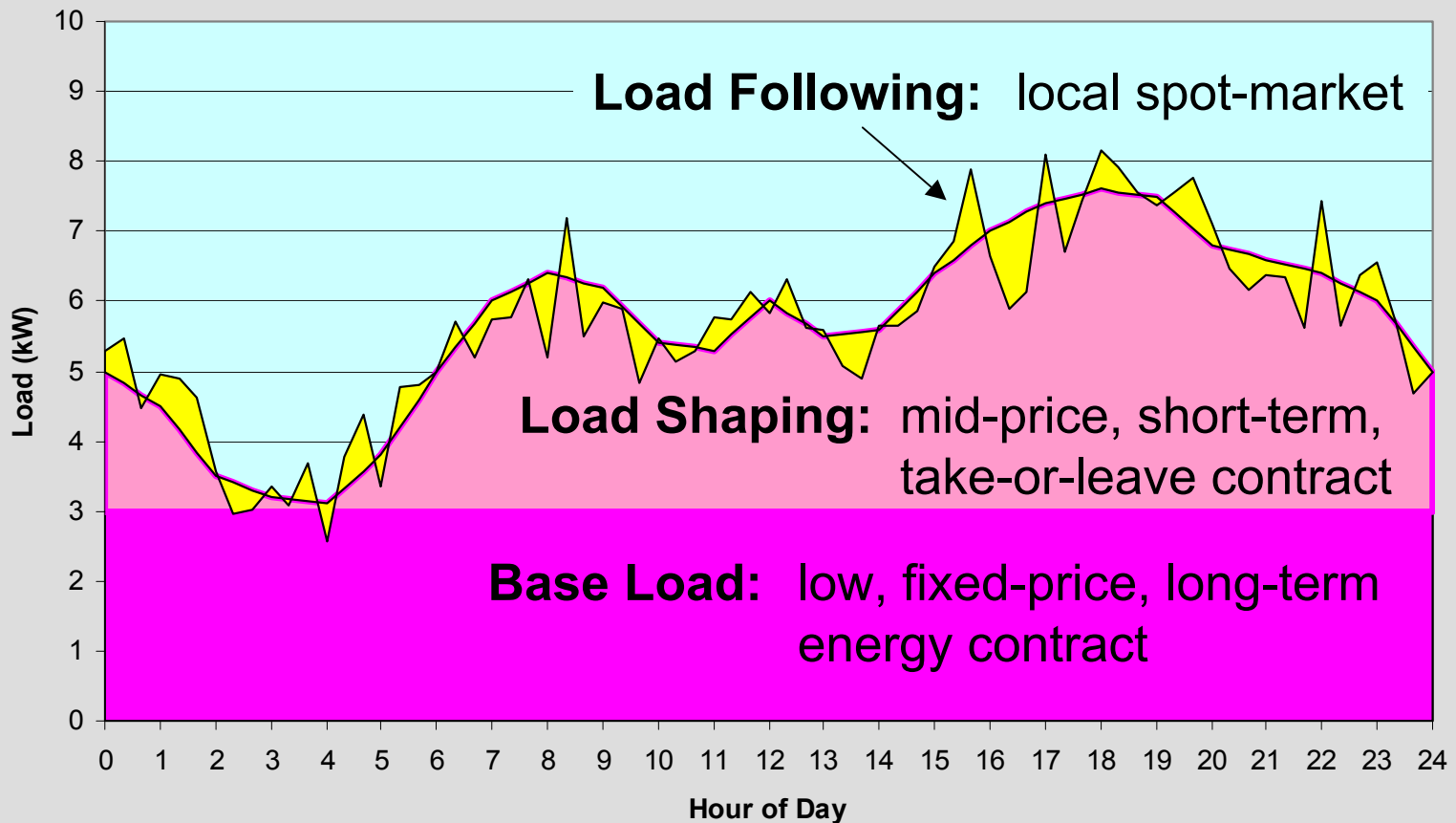
New Markets & Technologies

Span System Levels, Time Scales



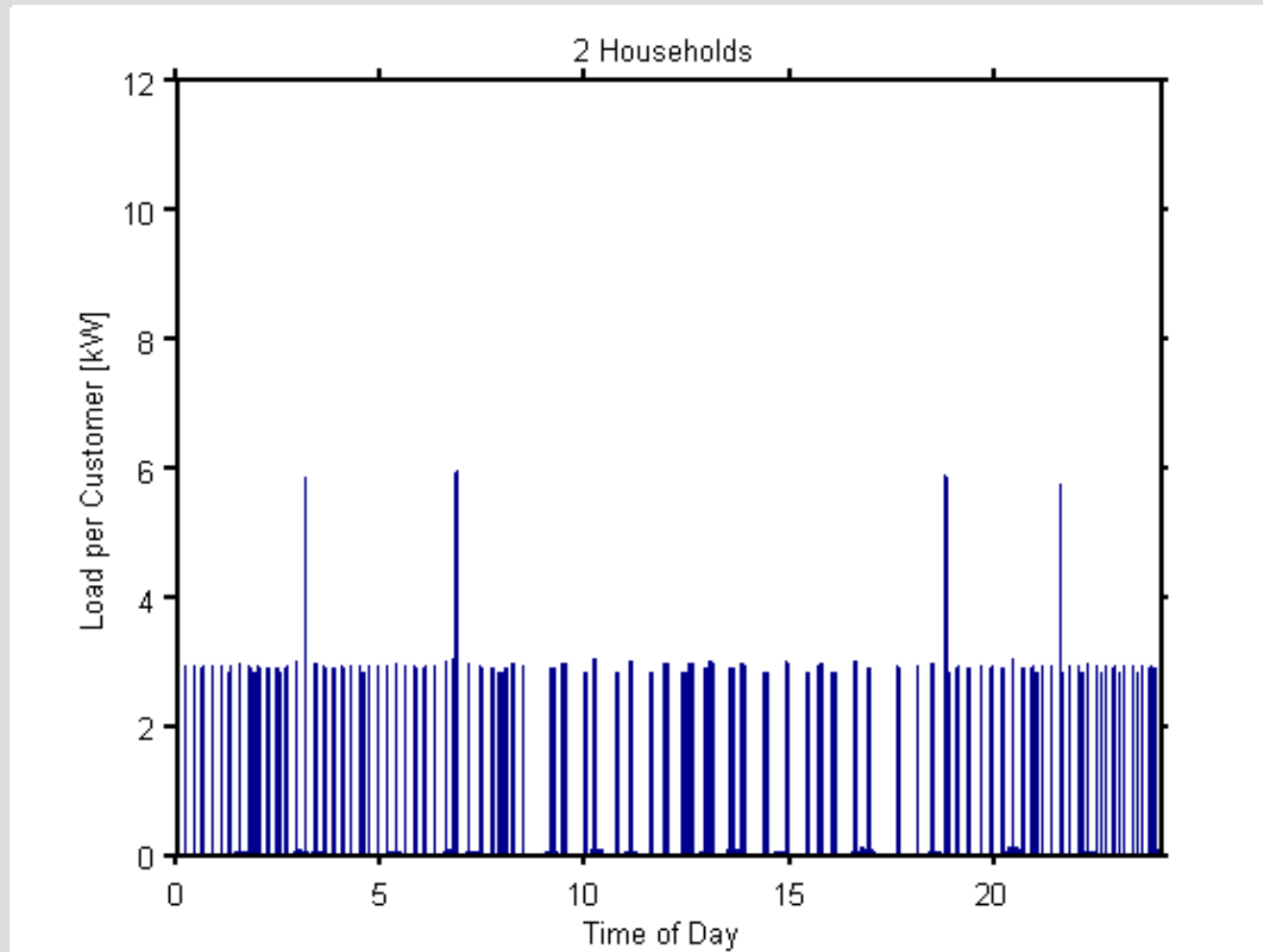
“Just-in-Time” Dynamic Operations

Loads, DG, Storage, Power & T&D Contracts with Utility or Aggregator

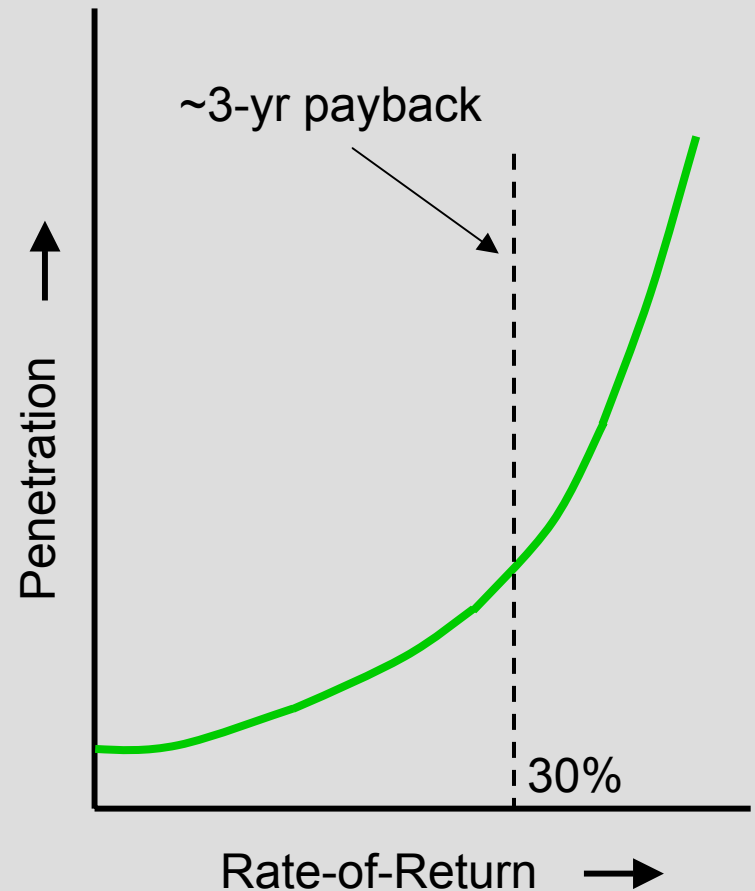
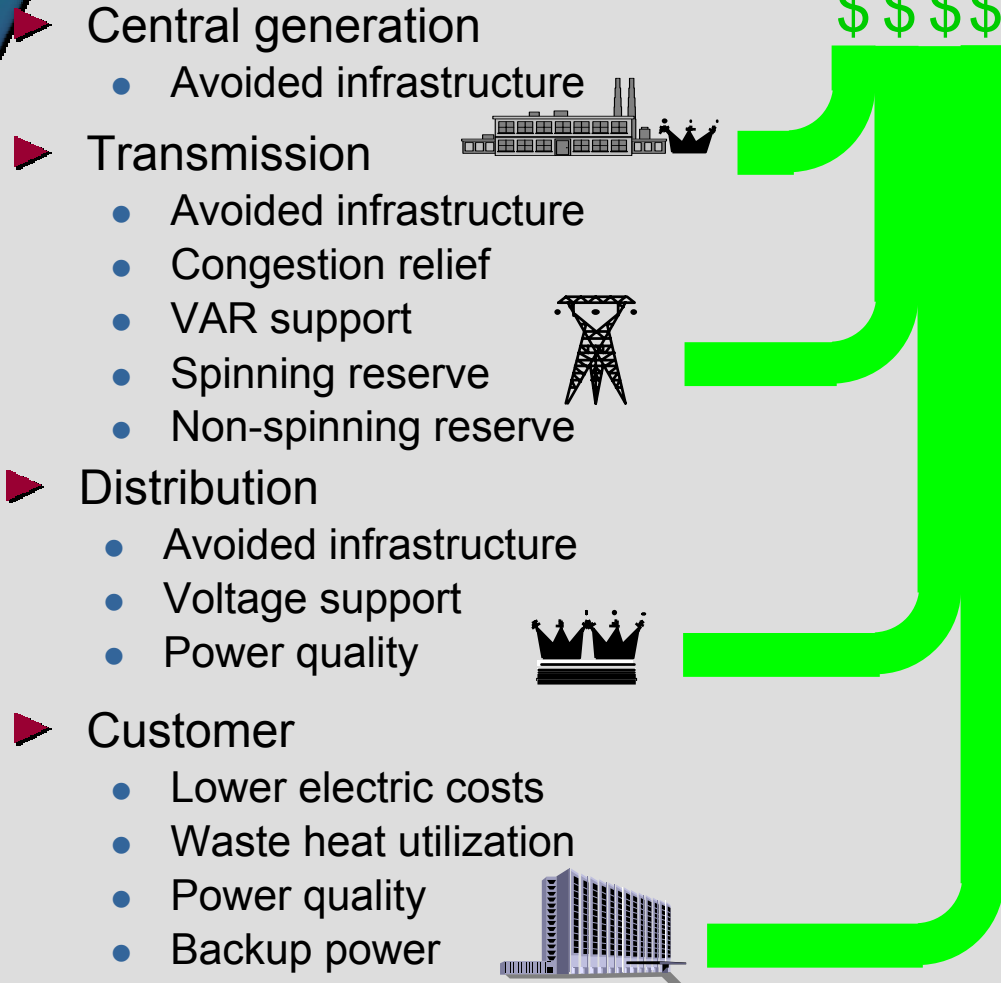


Role of Diversity

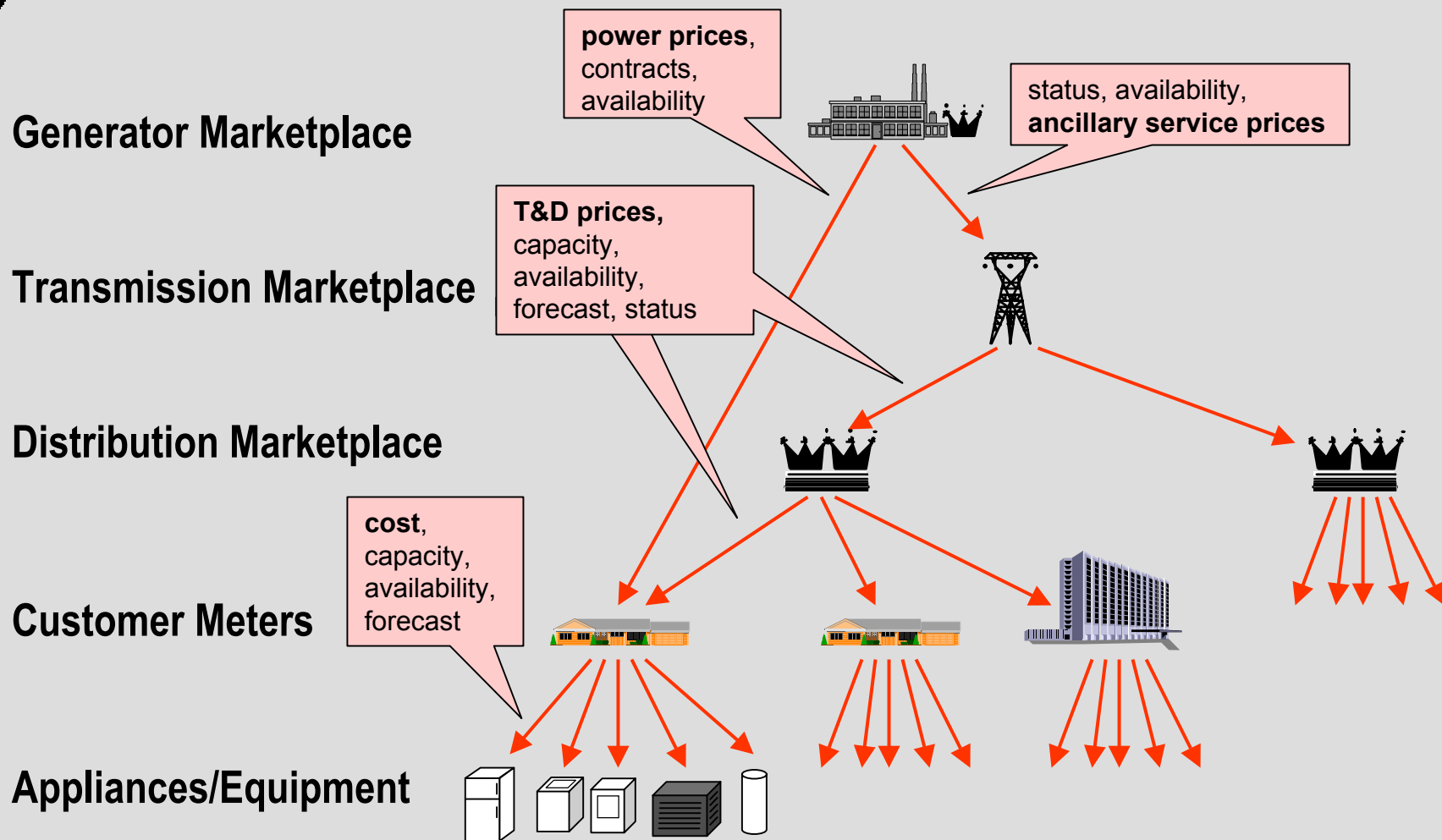
Location & Time



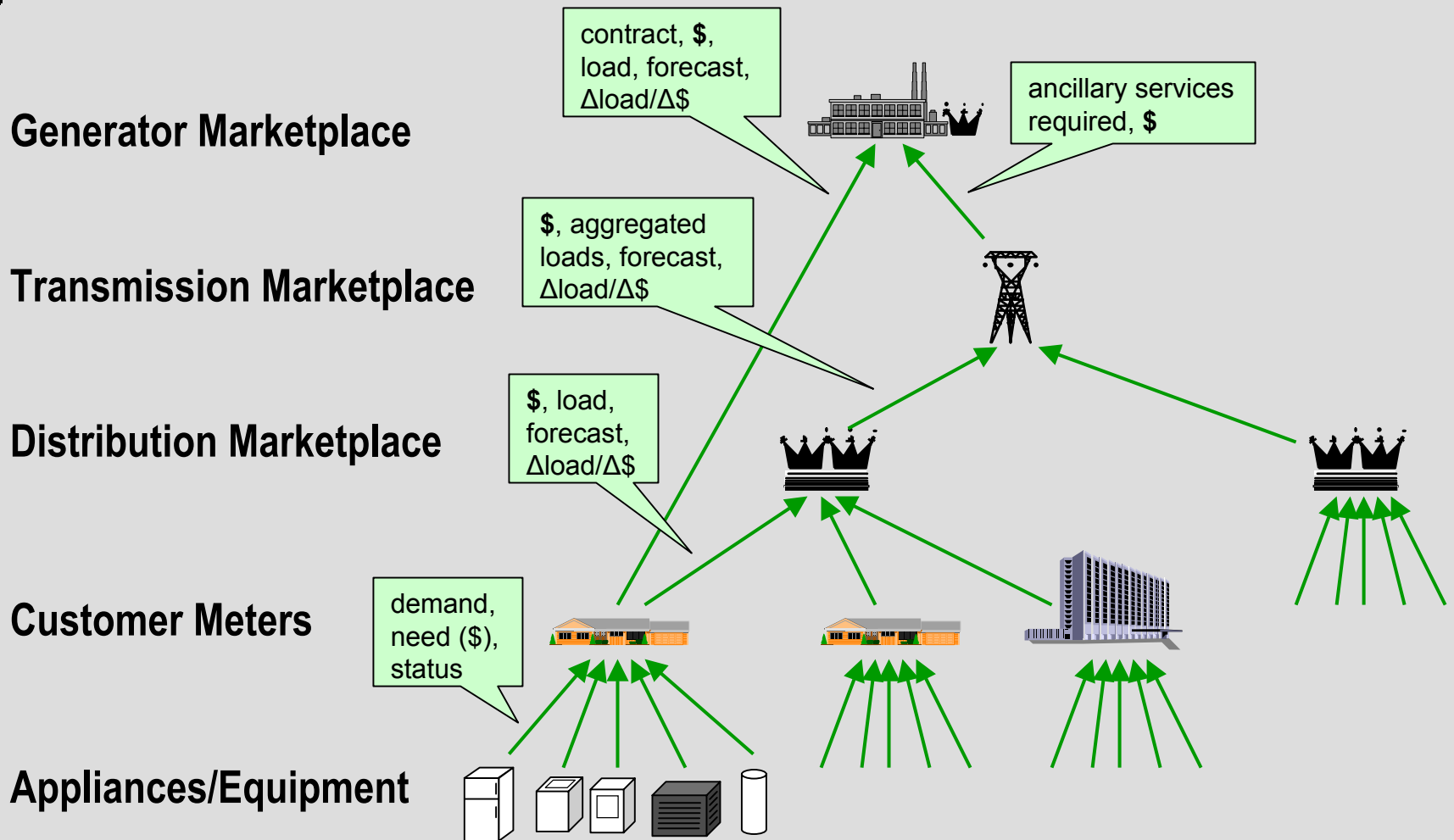
Accumulating the Value Chain Accelerates Penetration of Distributed Resources



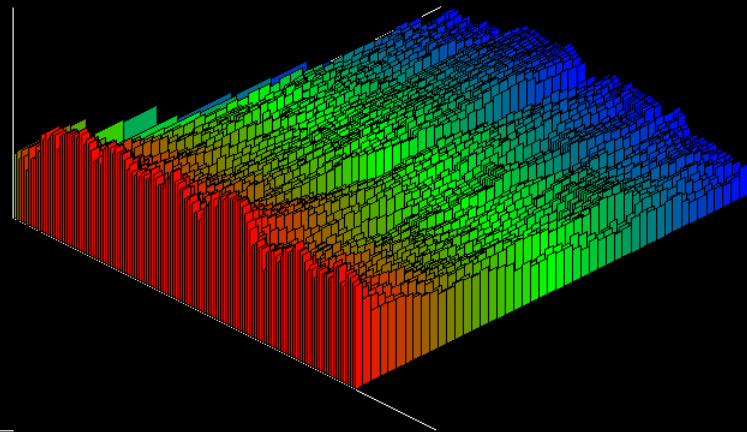
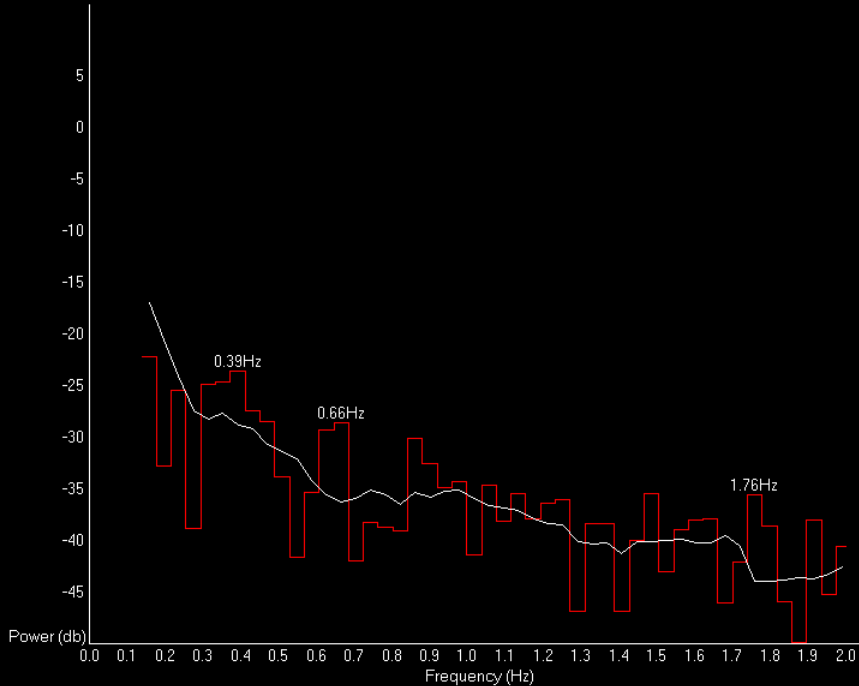
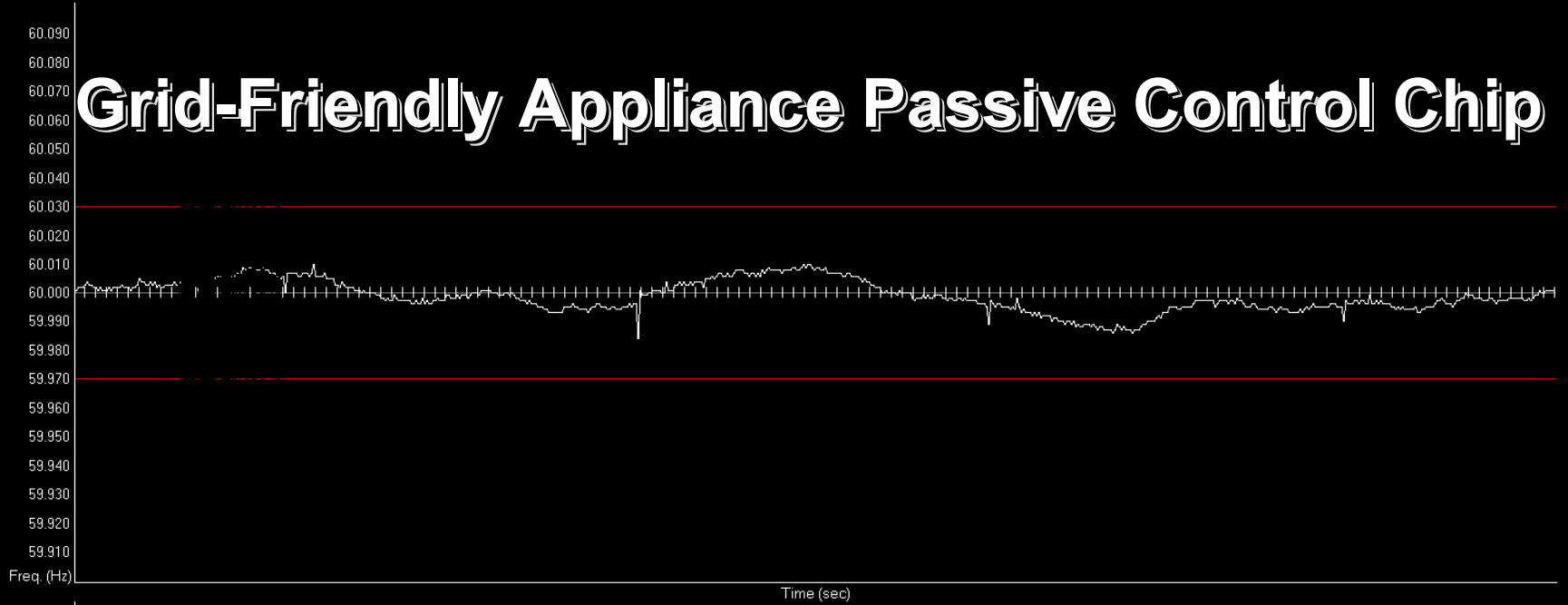
Downward Communication of Availabilities, Prices, Forecasts, Capacity Expansion Plans



Upward Communication of Current & Expected Loads, Status, Operation & Construction Plans



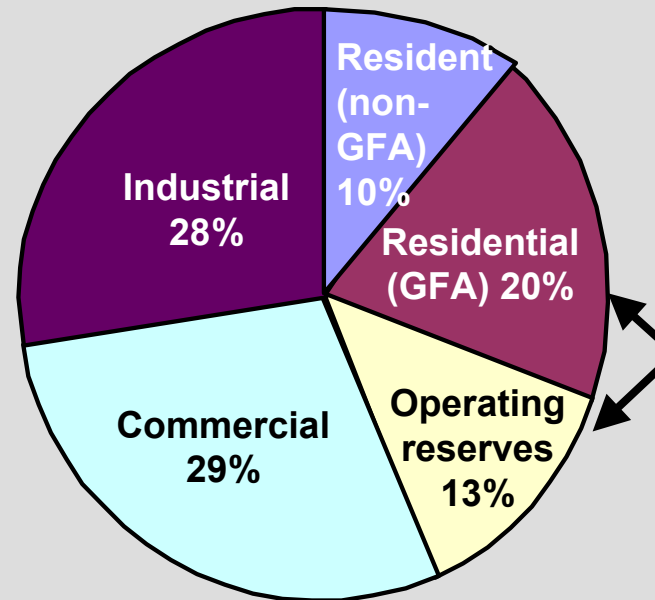
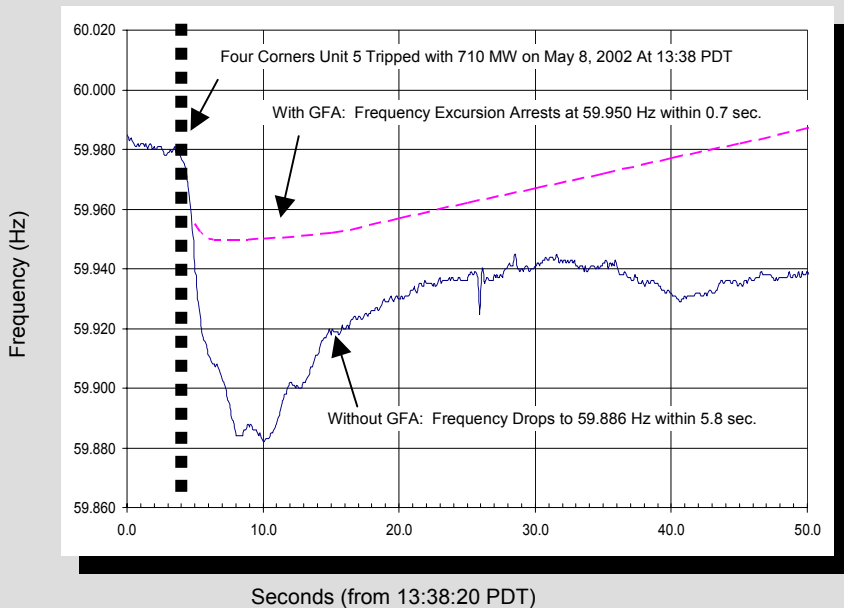
Grid-Friendly Appliance Passive Control Chip



Grid-Friendly™ Appliances (GFAs) Help Keep the Lights On

Grid-Friendly Appliances Sense Frequency Excursions & Control Appliances to Act as Spinning Reserve

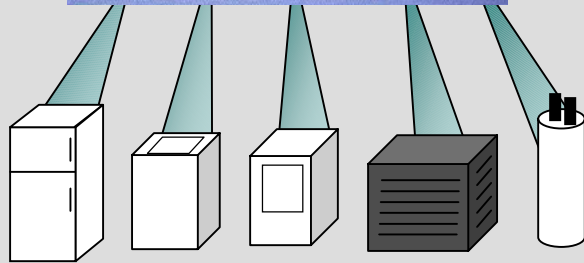
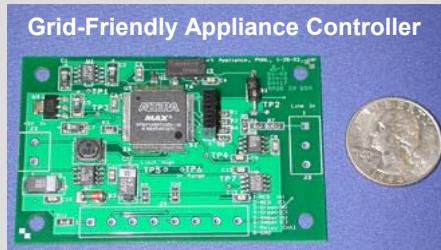
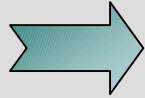
Loads and Reserves on a Typical U.S. Peak Day



GFA potential exceeds US operating reserve requirements!

Grid-Friendly™ Appliances (GFAs) Help Keep the Lights On

Millions
of GFAs



Grid-friendly appliances...

- ...rapid, automatic response to grid crises
- ...platform for active communication & control
- ...pre-heat/pre-cool to coast through peaks
- ...utilize & value thermal storage
- ...increase reliability & security
- ...unnoticeable by consumer
- ...mass customization/marketing

*eliminate need for 100s
of new power plants,*



*saving tens of billions
of dollars over 20
years.*

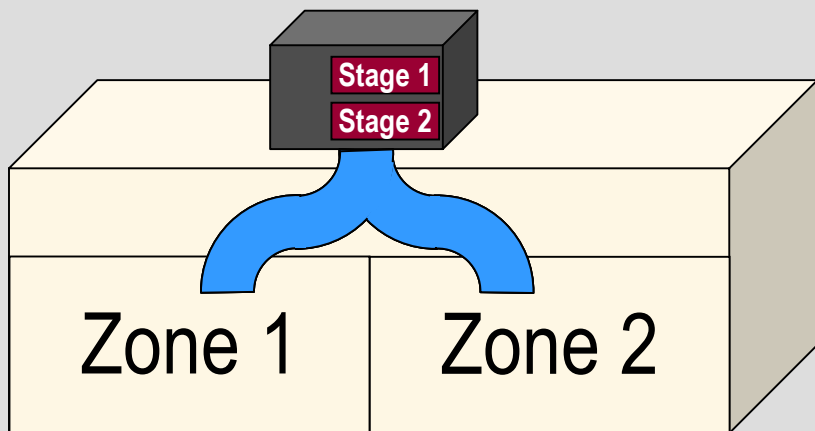


**“...given enough ants, you
can move a mountain!...”**

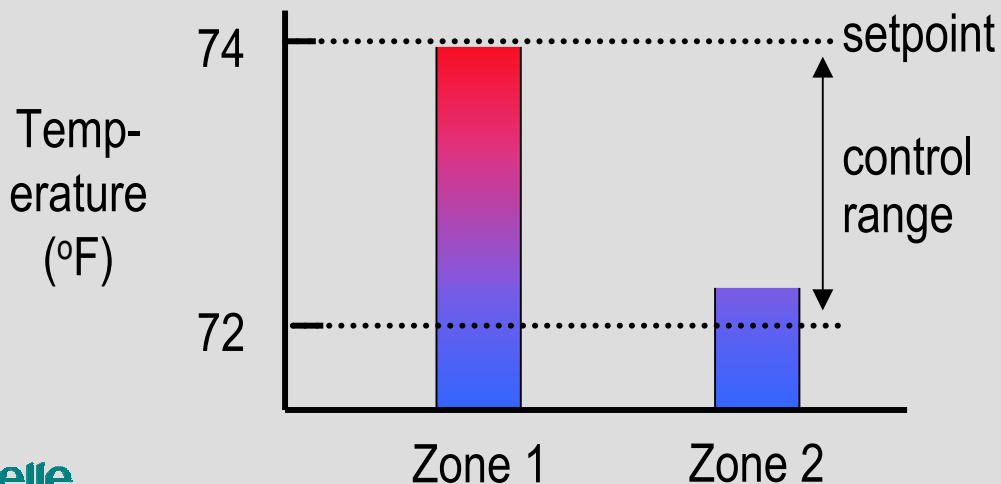
impromptu reaction from a utility power engineer

Traditional Control — Satisfies Absolute Demand Regardless of Cost or Grid Conditions

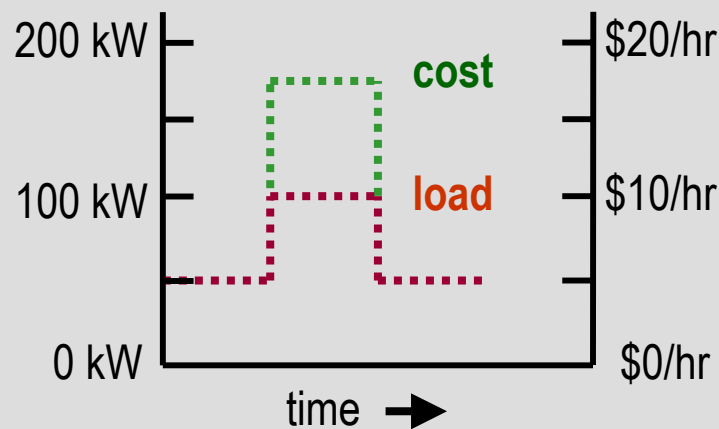
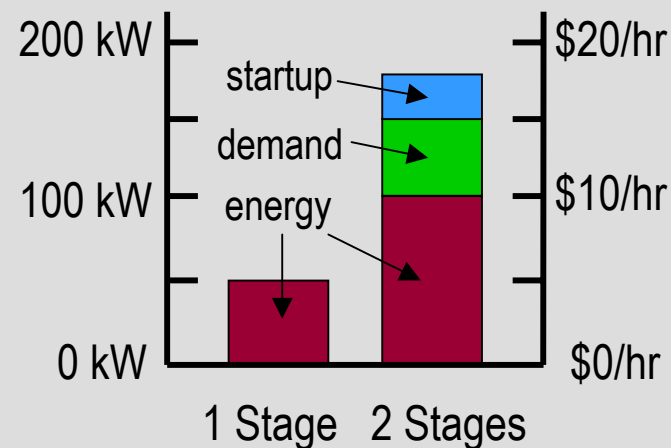
Commercial Bldg.



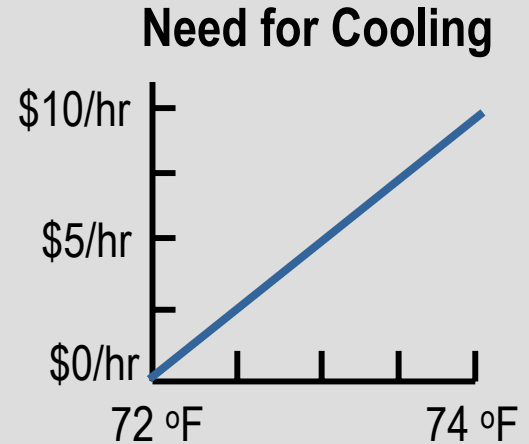
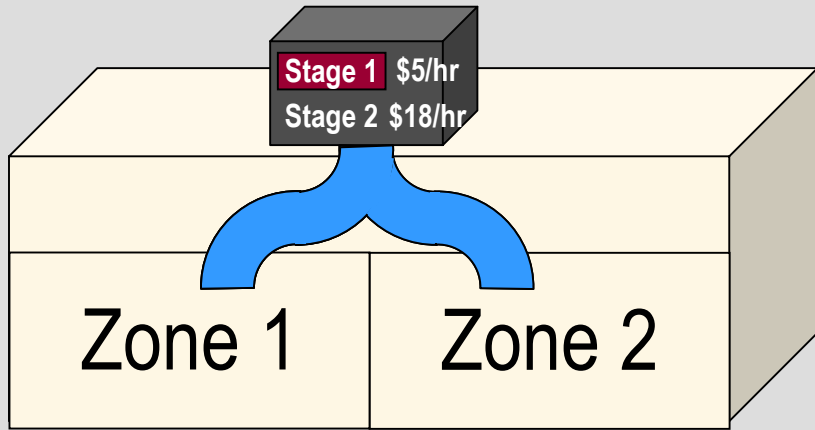
Cooling Demand:



Cost of Cooling



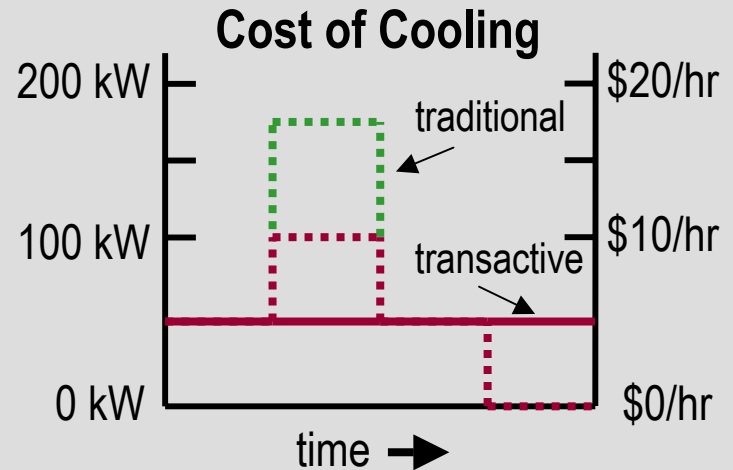
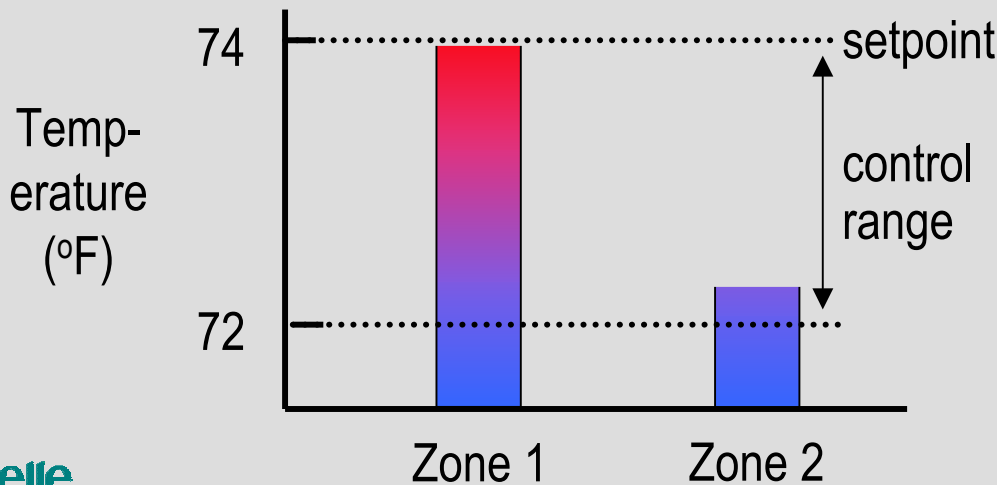
Transaction-Based Control — Relative Need Expressed as Willingness to Pay; Control System Minimizes Cost



Cooling Need pay up to:

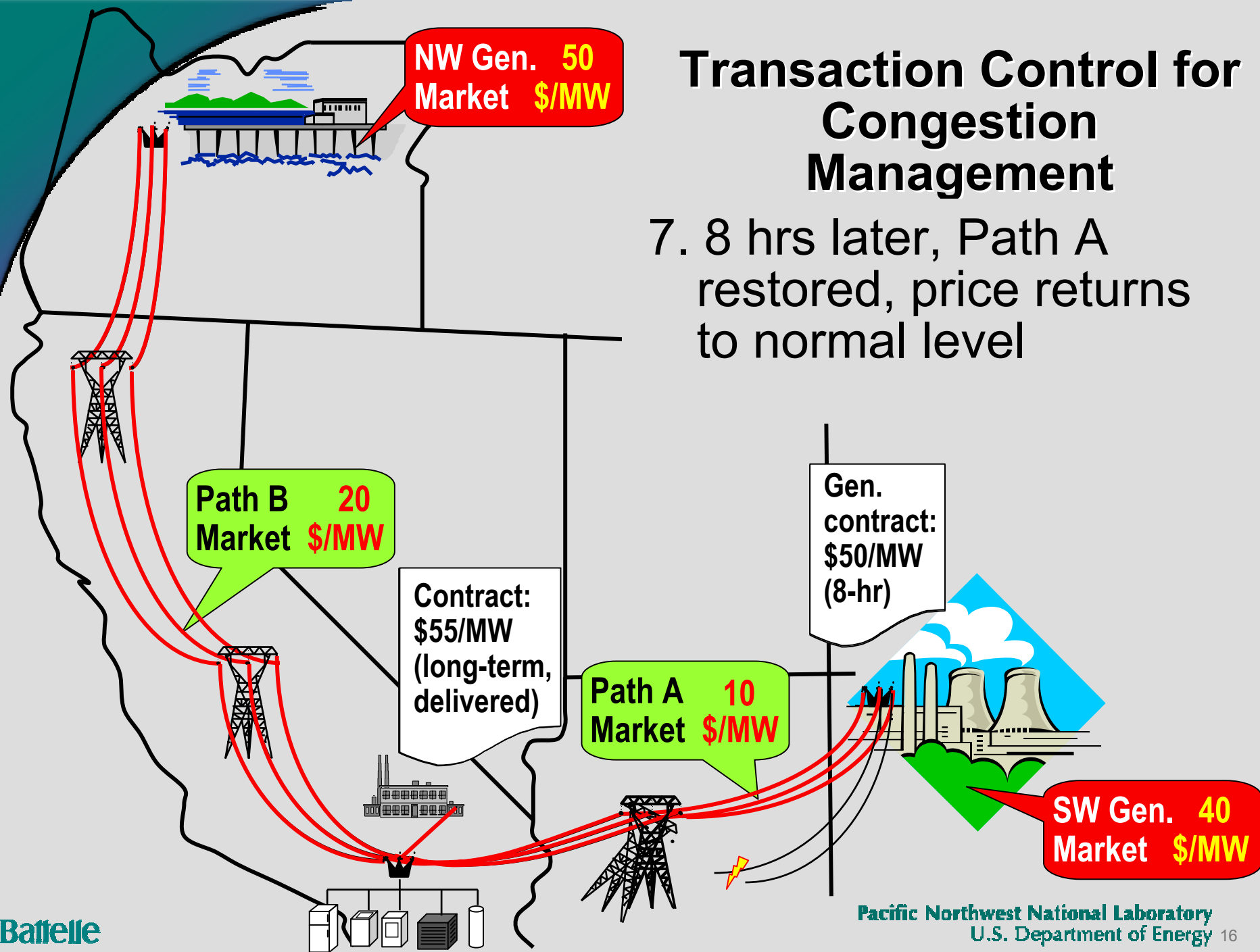
\$4/hr

\$8/hr

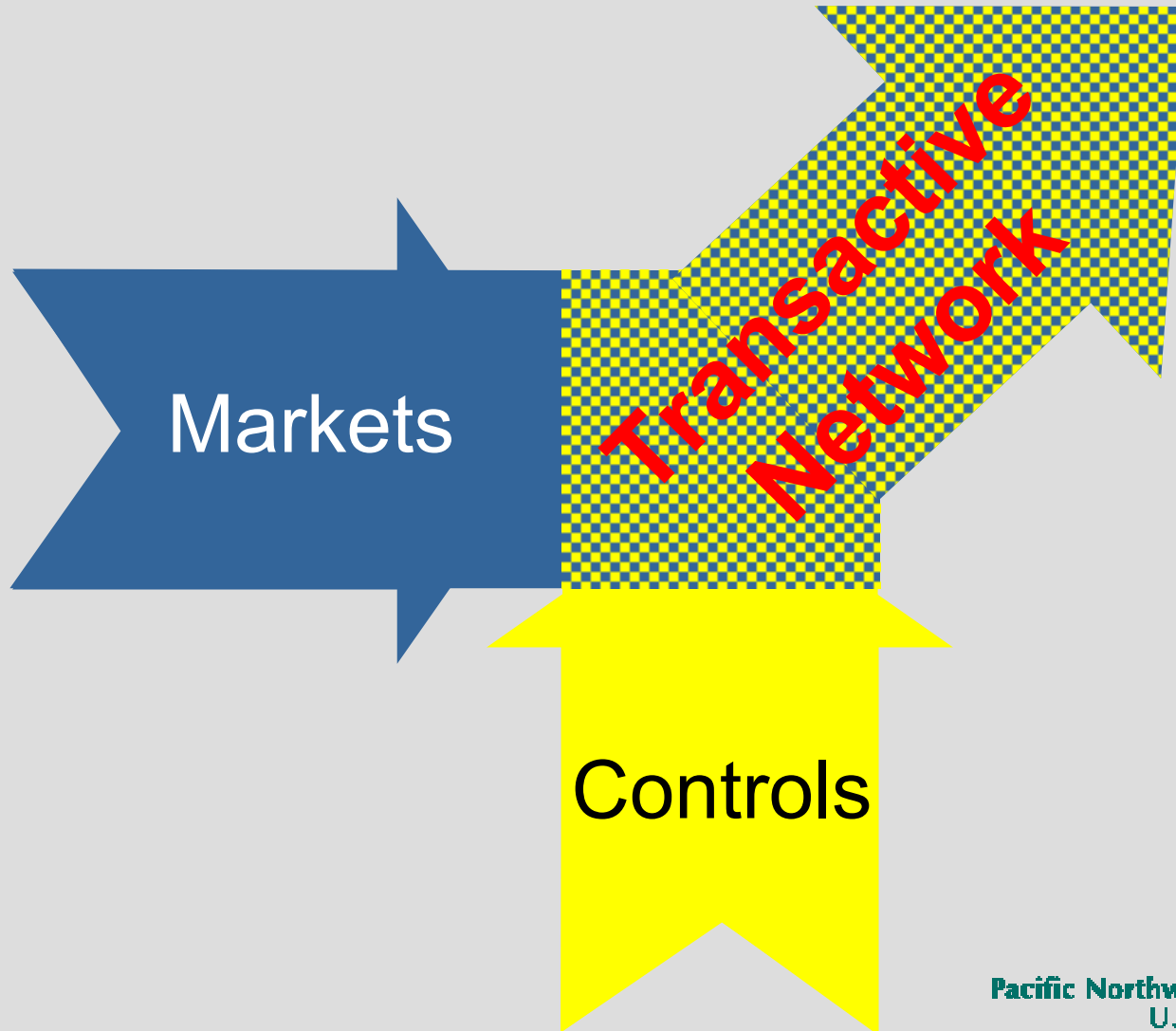


Transaction Control for Congestion Management

7. 8 hrs later, Path A restored, price returns to normal level



GridWise Markets and Controls Merge to Form a Transactive Network

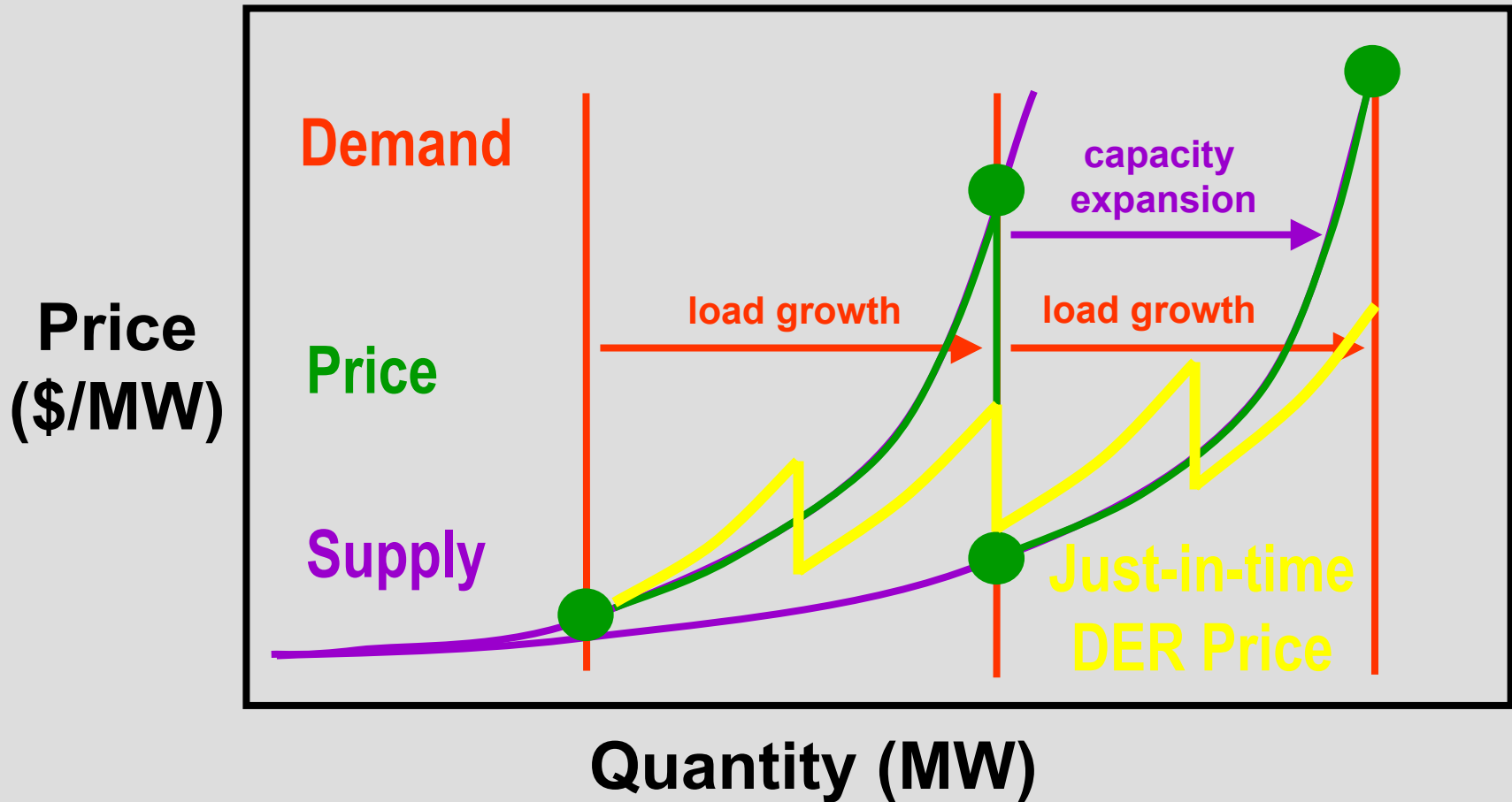


DC / Flexbus Increases End-User Electrical Efficiency

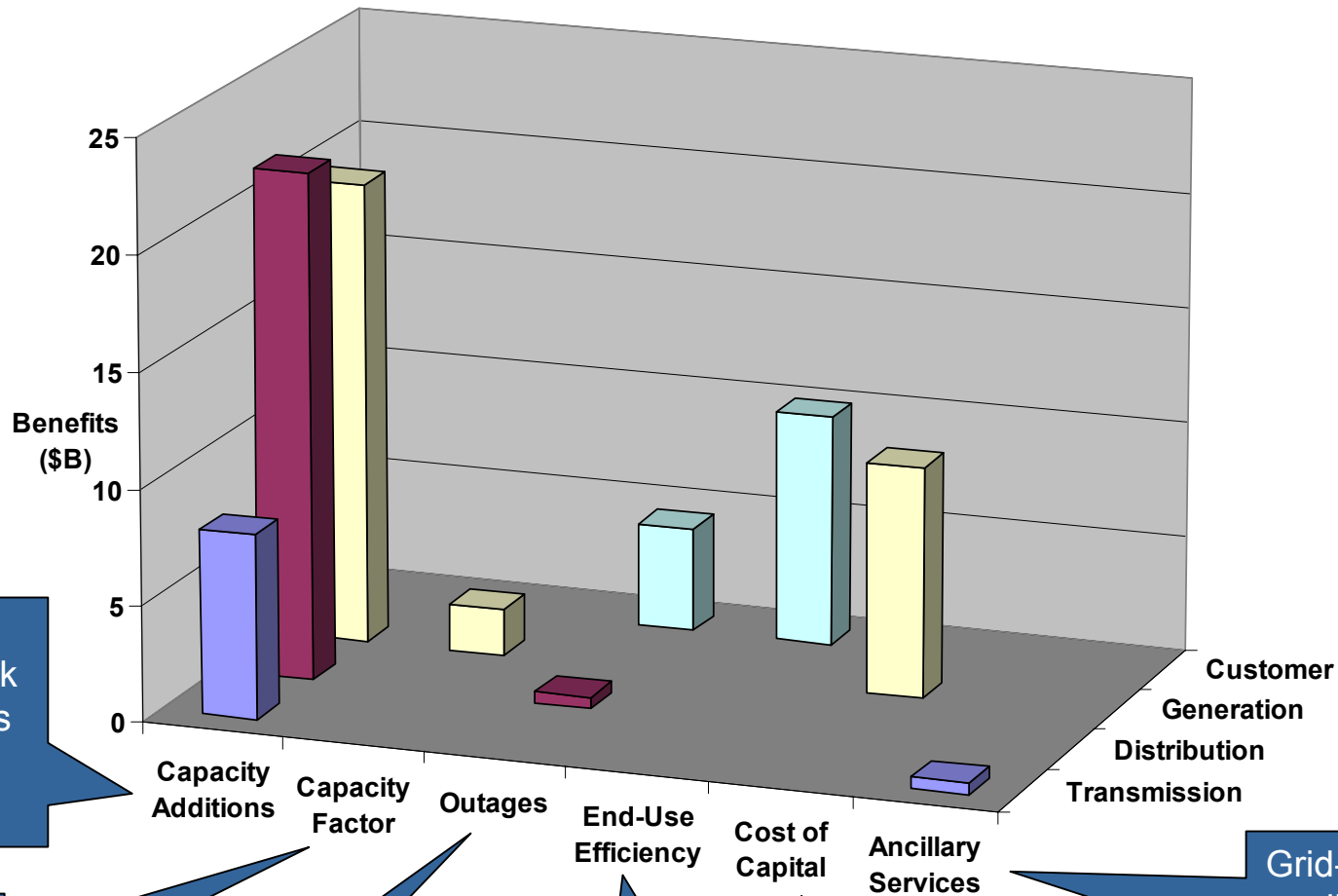
- ▶ Efficiency from grid to server electronics is often 42% or lower. Wasted electricity goes to heat, which causes additional air conditioning loads and even lower overall efficiency.



The Value of Just-In-Time Capacity: Timely and Smaller Increments Mitigate Price Volatility & Boom-Bust Cycle



Benefits Exceed \$80B (20-yr PV)



Actively managing peak demand defers construction: ~\$50B

Better utilization of existing generation: ~\$2.5B

Active grid management reduces outage costs: ~\$5B

Advanced controls & diagnostics increase customer efficiency: ~\$10B

Reducing risk premium by just-in-time capacity markets lowers bond rates 1%: ~\$10B

Grid-friendly appliances & equipment supply required spinning reserve capacity: ~\$0.5B

Information: *the Virtual Energy Infrastructure*



GridWise™ Principle 1:

$MC^2 \equiv e$

Markets + Communications + Control
 \equiv
energy infrastructure

GridWise™ Principle 2:

\$ bits \ll \$ iron

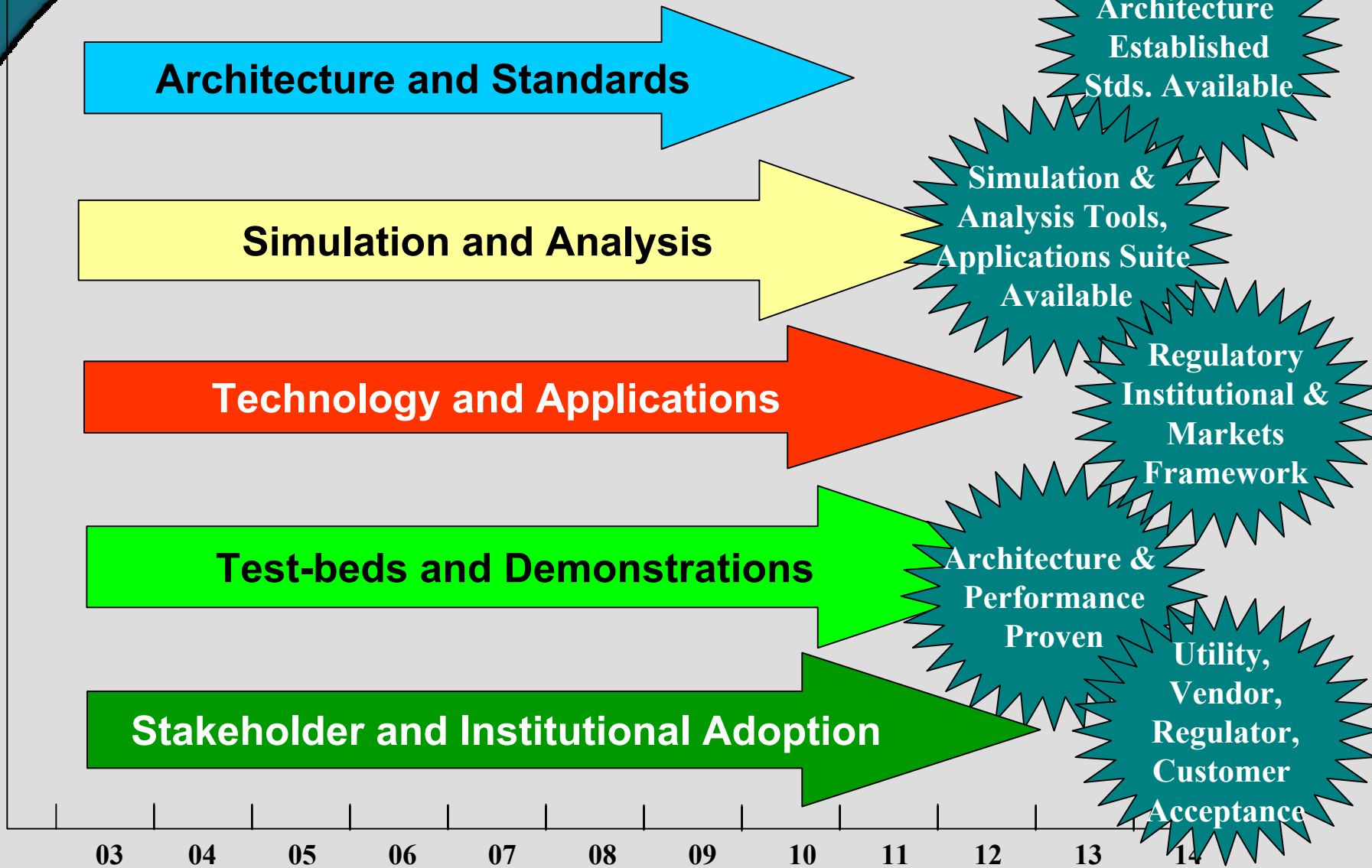
Investing in a 21st Century Electric System

Industry is Already Mobilizing

- ▶ **Wide variety blue-chip & high-tech startup corporations embrace the vision**
 - GridWise™ Alliance Board
 - Sempra Energy Solutions
 - PJM Interconnection, LLC
 - Alstom Esca Corporation
 - IBM Global Energy & Utilities Industry
 - The Rockport Group
 - CEO Coalition
- ▶ **Federal role** is to make the vision broader, more integrated, occur sooner, and ensure public benefit



Long Range Program



Technology & Applications – Strategy

